Carnegie Mellon University
Software Engineering Institute

Best Training Practices Within the Software Engineering Industry

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November 1996

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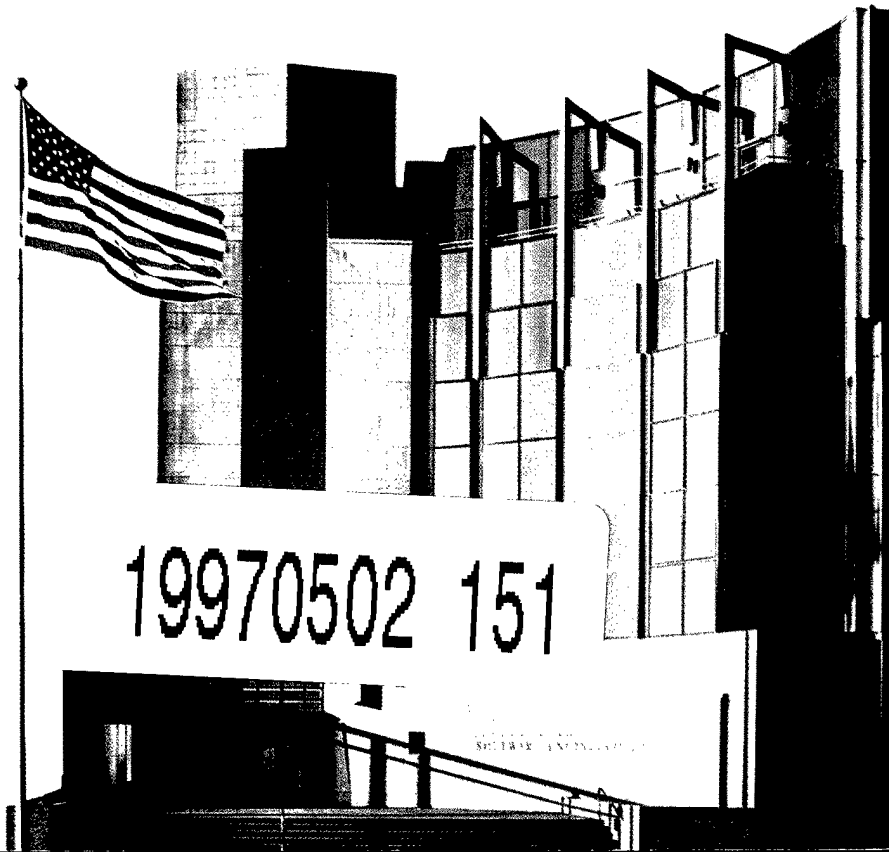

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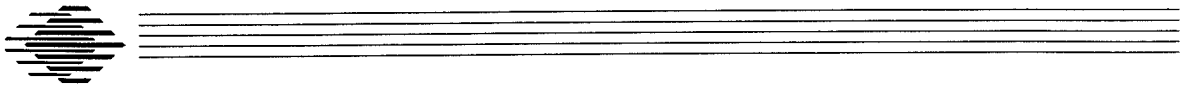

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FOR THE COMMANDER

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Acknowledgments

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Executive Summary

This section provides a general summary of the findings from the benchmarking study, along with a brief description of the process used and the purpose of the study. Chapter 4 contains a more thorough discussion of the findings, and Chapter 5 provides the specific practices and enablers to those practices that we identified.

Background

This report documents the results of a benchmarking study to identify the best training practices and support training initiatives within the software engineering community. The study was divided into two phases. In the first phase, we collected and analyzed information from a number of organizations to create a broad picture of training as it currently exists in industry. In the second phase, we targeted three organizations for an in-depth study.

Phase One

We sent a survey to over 100 educators from industry, academia, and government in the United States and abroad. We received 24 responses.

Based on the findings of the survey, we did not believe that any one organization embodied the best practices in all the categories listed. Instead, we needed to look at several organizations to identify the best practices. We chose three companies based on the fact that (1) their responses indicated that training had a significant effect on software engineering within their organization, and (2) their training processes were evaluated to be very effective. See Chapter 2 of this report for more details.

Summary of Best Practices

The three organizations that were benchmarked had certain practices in common, which we viewed as indicators of why they could be considered the best. [1]

[1] The persons interviewed during phase 2 of this study represented select areas of the companies involved. Therefore, the practices and enablers reported here are not necessarily representative of the company's practices as a whole.

These practices included

- a defined process for software engineering education
- a formal needs analysis activity
- availability of a wide variety of courses from different sources
- training by a local, respected organization

See Chapters 4 and 5 for more details.

Summary of Enablers to Best Practices

The enablers to best training practices generally included the following:

- process and quality improvement
- management involvement and support
- employee involvement
- timing of delivery compared to the identified need
- availability of training

See Chapters 4 and 5 for more details.

Areas of Improvement

Most organizations reported flat or declining training budgets. They had learned to do more with less. As a consequence, the number of hours available to each employee on an annual basis seemed low relative to what would be needed to keep up with the field.

Few organizations did return-on-investment analysis relative to training, and those that did could not readily attribute improvement to training. Usually the improvement was seen as part of a larger activity, such as software process improvement.

Best Training Practices Within the Software Engineering Industry

Abstract: This report provides the results of a benchmarking study to identify the best training practices within the software engineering community. We surveyed 24 organization to create a broad picture of training as it currently exists in industry. We then chose three of these organizations for an in-depth study to identify the best training practices and enablers to those practices. This report summarizes the results of the survey and the in-depth study, and discusses the best practices and enablers that were identified.

1. Overview

1.1 Purpose

The purpose of this report is to document the results of a benchmarking study to identify the best training practices within the software engineering community. The report does not set forth a process to follow, rather it presents the way the benchmarking study was conducted and the results that it generated.

1.2 Intended Audience

The primary audience for this report is educators in industry who may want to use these best practices as reference points for establishing training programs within their own organizations. A secondary audience may be individuals doing Capability Maturity Model[sm] (CMM[sm])-based process improvement, especially those trying to implement the Level 3 key process area "Training Program."

1.3 Background

Problem statement

At the 1995 Software Engineering Institute (SEI) workshop, "Advising Management About Derived Benefits of Software Engineering Education and Training," a gap in training information was discovered. Organizations were asking for best training practices information that did not exist in a usable form.

[sm] CMM and Capability Maturity Model are service marks of Carnegie Mellon University.

The benchmarking study was initiated to solve this problem. Our objective in performing this study was to identify the best training practices and support training initiatives within the software engineering community.

Structure of the Study

The study was divided into two phases. In the first phase, we sent a survey to a number of organizations to create a broad picture of training as it currently exists in industry. We collected the results and analyzed them. In the second phase, we identified three organizations to benchmark. Benchmarking teams led interviews, collected more findings, and identified specific best training practices and enablers.

The Teams

The first phase of the study was undertaken by the SEI, in conjunction with Lawrence Tobin Associates, Inc., a private consulting firm in Maryland.

The second phase of the study was led by a benchmarking team of five individuals: Larry Tobin, Lawrence Tobin Associates; Mary McComb, Lawrence Tobin Associates; Marsha Melkonian, Internal Revenue Service (IRS); Nancy Mead, SEI; and Maribeth Carpenter, SEI. This team was divided into subteams, each of which contacted one of the companies selected for further study.

1.4 Benchmarking

In general, the purpose of a benchmarking study is to uncover better ways of performing some activity—in this instance, training. The objective is to improve practices by looking to others for new approaches, new ideas, or entirely different management philosophies. In benchmarking, the *best practices* of industry leaders are adopted. The term "best practices" refers to the methods used in work processes whose outputs best meet customer requirements.

The focus is on industry leaders because they provide the best examples to emulate. For this study, industry leaders were defined as companies having the best training process. This focus on process allowed us to consider organizations regardless of their product or industry affiliation. Since it is not always possible or desirable to copy processes from one organization to another, we focused on *practices* and *enablers*. Practices and enablers are a way to look at the inner workings of a process independent of how the process is implemented in a particular organization. Practices are defined as what we have to do to achieve a result. Enablers are what we have to do to make the process work. Chapter 5 describes the practices and enablers used by the three industry leaders that we studied.

2. Phase One

2.1 Description of the Survey

We sent the survey to over 100 educators from industry, academia, and government in the United States and abroad. These educators were selected from an SEI database of people who had attended past education conferences and workshops conducted by the SEI. We chose people who we believed were responsible for education in their organizations.

The survey consisted of 37 multiple-choice questions organized into five sections. (A copy of the survey is provided in Appendix A.)

1. Introduction: questions about the existence of a software process improvement program and whether training resulted in improvements to software engineering within the organization
2. Staff development: questions about the level of support for training, the degree of satisfaction with the training, and whether training budgets were increasing, decreasing, or staying the same
3. Training process: questions about who provides training (e.g., a separate group within the organization, outside vendors, or universities); whether training procedures were documented; and whether they used computer-based training or instructor-led training
4. Measurement: questions about what data the organization collected to determine the value of training and who collected these data
5. Planning and requirements: questions on the use and maintenance of training plans, the existence of a mission/vision statement, the use of assessments to determine training needs, and the effectiveness of the training process

We received 24 responses to the survey. Most of the respondents were from the United States, with one response from a European organization. Organizations that responded to the survey included: GTE, Loral Federal Systems (now Lockheed Martin), Florida Atlantic University, IBM, TRW, Lockheed Martin, Philips/Research, Westinghouse, and Northrop Grumman.

2.2 Survey Results

We organized the survey results into the five categories that were described in section 2.1. The response percentages reported for each question were calculated from only the number of responses that we received for that question, not from the total number of surveys that were completed. The actual data from the survey are contained in Appendix B.[2]

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[2] Tobin, Lawrence. *Benchmarking Study to Identify Best Practices Within the Software Engineering Industry*. Simpsonville, Md.: Lawrence Tobin Associates, Inc., November 1995.

2.2.1 Summary of Findings

Based on the findings of this survey, we determined that no single organization embodied the best practices in all the categories we studied. Instead, we needed to look at several organizations to identify the best practices (this activity was done in Phase two of the study).

Although the small response to the survey limits its usefulness as a guide to organizational training, the results do lead to some valuable insights:

- For the respondents, return on investment was not an indicator of the value of training. Training is not seen as an instant money maker. Instead, management seems to see it as a means to achieve certain organizational goals.
- Planning is an important element in training. In addition, respondents seem to recognize that continuous improvement is required for a high-quality training program.
- Based on this group of respondents, it seems that training has not achieved the goals set out for it. With only 18% of the respondents indicating that training resulted in significant improvements in software engineering, there seems to be an opportunity for improvement in training.

The following sections provide the detailed results of this survey. If you are interested primarily in the general findings and best practices and enablers of the organizations we studied in depth, see Chapters 4 and 5.

2.2.2 Introduction

The first question of the survey asked whether training was provided to any members of the work force. The response was 100% yes. More specifically, all respondents reported that training was provided in software-related fields.

Of the 17 responses to the question about the existence of a software process improvement program, 100% of the respondents reported that they did have such a program.

The effect of training on software engineering is shown in Figure 1.

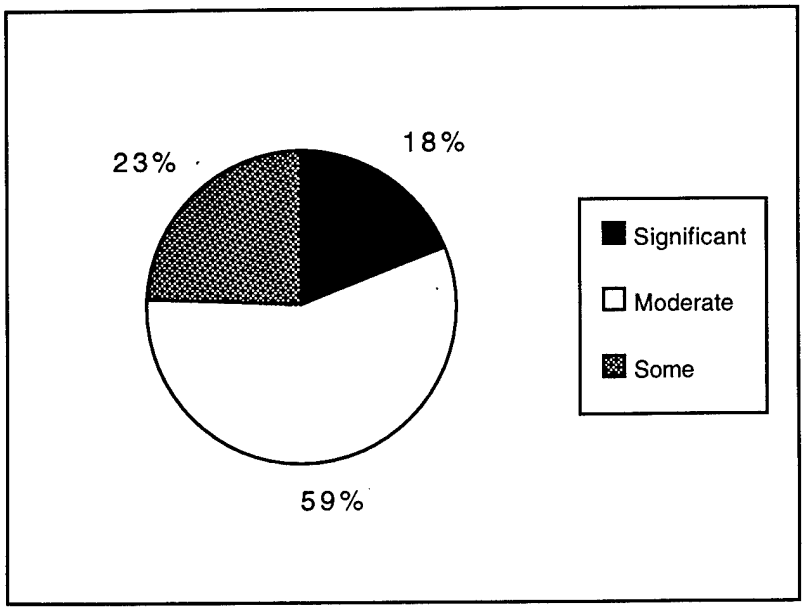

Figure 1. Effect of Training on Software Engineering

2.2.3 Staff Development

The average number of employees in software-related fields was 1,806. Responses to question 3 indicate widespread support for software engineering training: 79% of executives, 92% of middle managers, and 88% of supervisory or project-level management support training. Employees were encouraged by management to attend training (88%), and all respondent organizations allowed time for training during working hours. Data on employees' degree of satisfaction with training were not so definite (see Figure 2).

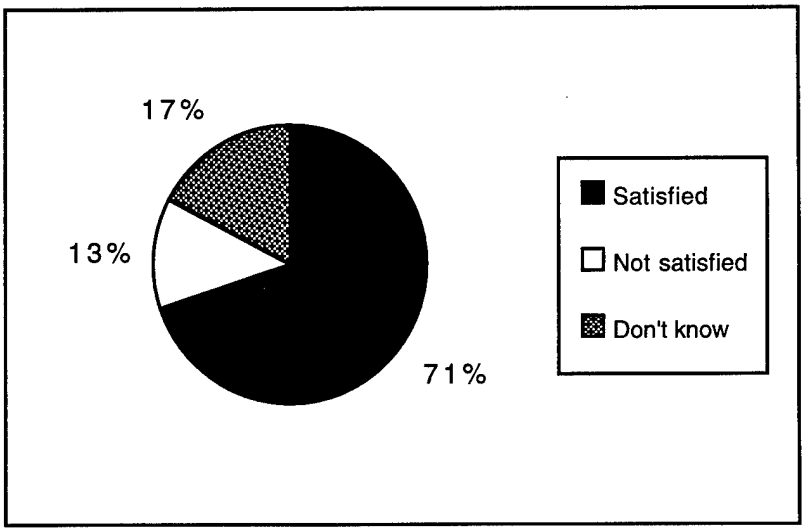

Figure 2. Degree of Satisfaction with Training

Only 14% of respondents indicated that overall training budgets had increased, while 68% indicated that general training budgets were either decreasing or staying the same. A relatively large number of organizations (81%) reported that they had a separate overall training budget.

A similar trend appears for organizations that maintain a separate budget for software engineering and related training . In these organizations, the budgets for software engineering and related training were increasing for 30% of the respondents, but decreasing or staying the same for 43%.

2.2.4 Training Process

Of the 24 respondents, 79% reported having a separate group responsible for software engineering and related training. The relatively low effectiveness of training (reported in the general section) may be partially explained by the fact that 57% of respondents reported that the training group was very knowledgeable of software engineering and related functions to begin with. The data shown in Figure 3 seem to indicate a robust training capability within organizations, supplemented when appropriate by outside vendors. They also indicate an increasing interest on the part of universities to engage in training, as well as education.

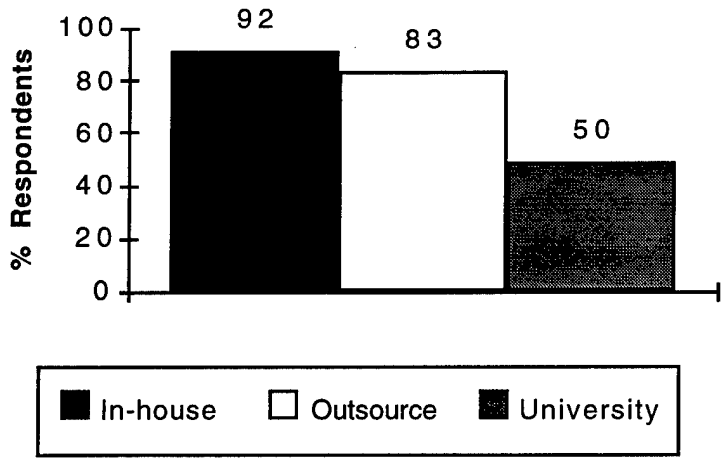

Figure 3. Source of Training Development

While the data indicate that organizations want to retain an internal capability for training development, organizations appear more likely to consider outsourcing for delivery of training. Eighty-three percent of respondents reported partially outsourcing training delivery, compared to 13% who did not outsource at all. Only 4% (1 organization) outsourced all of their training.

Consistent with the low effectiveness rating reported earlier (18% reported a significant effect on engineering), only 17% of the respondents reported that their training process was very effective. However, as shown in Figure 4, 71% felt that that their training process was effective.

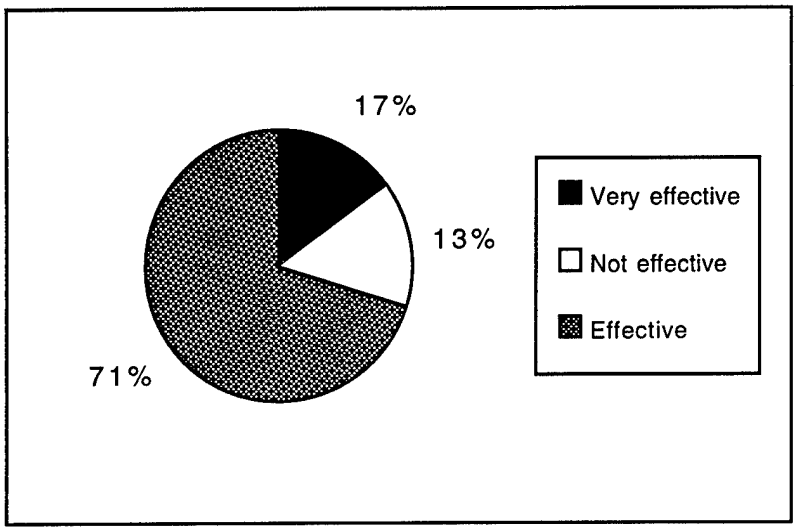

Figure 4. Effectiveness of Training

2.2.5 Measurement

Seventy-one percent of the respondents reported that their organization measured the value of training. As shown in Figure 5, the value of training was measured in a variety of ways: learning, application on the job, return on investment, and customer satisfaction.

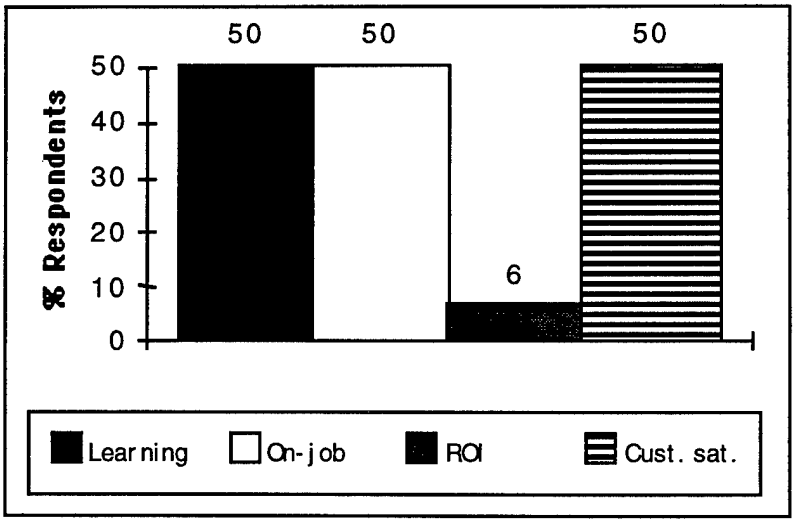

Figure 5. Types of Measures

While all respondents reported collecting metrics, only 88% reported keeping records of employee training.

Only 25% of the respondents reported that their organizations advertised the contribution of training to productivity. Perhaps this failure to advertise the value of training is related to the low rating for the effectiveness of training (see previous sections).

A significant number of respondents reported that training is independently evaluated by an outside group (46%), while 67% reported that senior management reviewed the training activities in accordance with a documented procedure. The responses to the question about the effectiveness of the measurement process are shown in Figure 6.

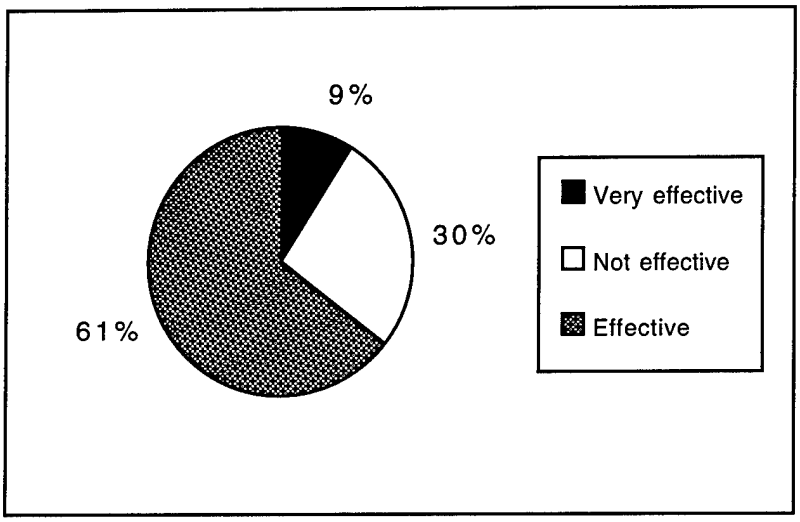

Figure 6. Effectiveness of Measurement Process

2.2.6 Planning and Requirements

Slightly over half of the respondents (58%) reported that their organization had a vision or mission statement for training. Even though 100% of the respondents reported that training existed in their organization, 21% said that there was no vision or mission statement for training and 21% did not know.

There seems to be considerable interaction between the training group and the operational managers (78%). This would suggest that the needs of the customer are at least partly heard by the training group. In addition, 75% of the respondents reported that assessments of training needs are performed always or sometimes.

The majority of respondents reported that training plans are prepared for individuals (54%) and organizational units (71%). The higher percentage for organizations suggests that training is seen as a means for achieving goals. The significant number of requests for training that is

not documented in a plan ("off-the-plan" training) also suggests a relationship between training and organizational goals. Figure 7 shows the percentage of operational managers, training managers, and employees that can request off-the plan training.

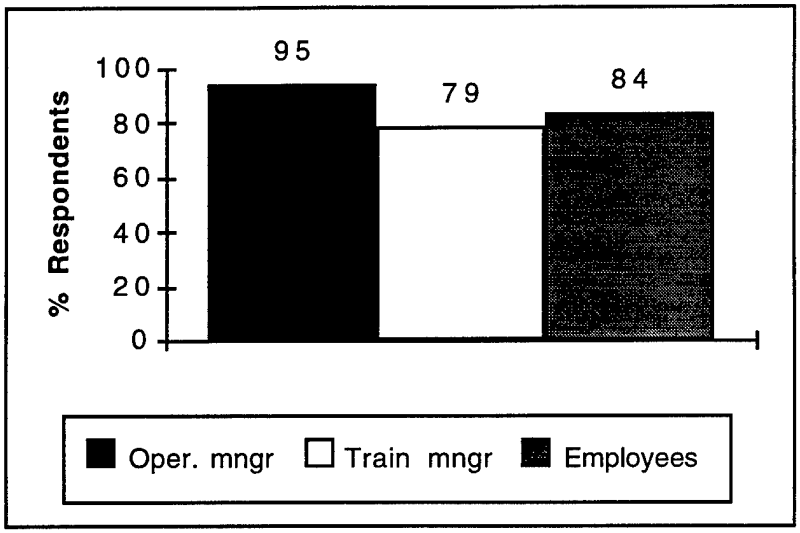

Figure 7. Requests for Off-the-Plan Training

The survey results emphasize the importance attached to maintaining training plans. Eighty-eight percent of respondents reported that their training plans were maintained.

Although 87% of respondents reported that training needs were sometimes met, none reported that they were always met. Again, this seems consistent with the low ratings for the effectiveness of training. On a more positive note, organizations seem to be responding to the need for training very efficiently (see Figure 8).

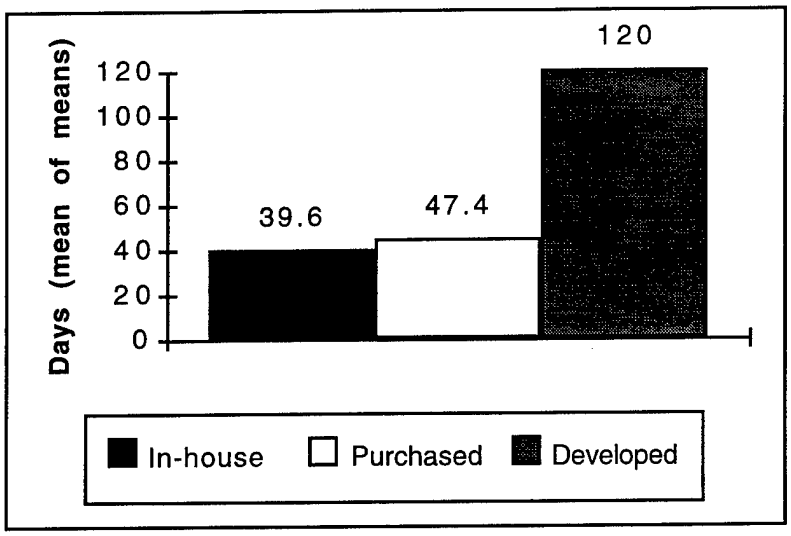

Figure 8. Time Required to Meet Training Needs

The effectiveness of the planning and requirements process is shown in Figure 9. Note that none of the respondents reported that their training process was very effective.

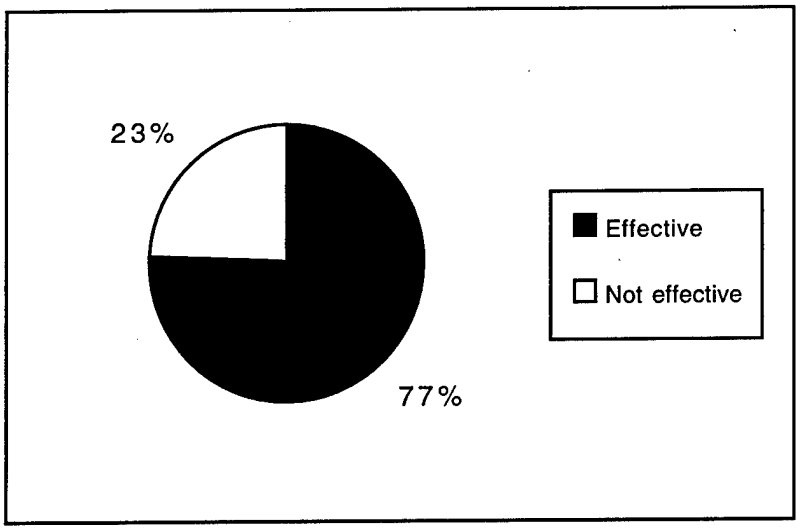

Figure 9. Effectiveness of Planning and Requirements Process

3. Phase Two: The Interview Process

3.1 Target Companies

Based on the results of the survey in Phase One of the study, we identified three companies for a benchmarking study of their training practices: Motorola, McDonnell Douglas, and IBM. These companies were chosen because:

1. Their responses indicated that training had a significant effect on software engineering within their organization.
2. They evaluated their training processes to be very effective.

It is important to note that the persons interviewed represented select areas of the companies involved. Therefore, the practices and enablers reported here are not necessarily representative of the company's practices as a whole.

3.2 Purpose of Interviews

The main purpose of the interviews was to identify practices and enablers of the companies being studied. The teams focused on identifying practices in the areas that the company had indicated as being positive or superior in the initial survey.

3.3 Data Collection

The benchmarking teams collected data primarily through telephone interviews, although they also reviewed some documents. During the phone interviews, the benchmarking teams used an open-ended interview technique to elicit more detailed information about the areas that we focused on in the survey. This process is not repeatable; that is, we would not expect that someone else could use the material provided in this report to get the exact same results. This material is provided for information only, so others can understand the process that we used to get the results.

Both the benchmarking subteams and the companies being studied used an interviewing guide that outlined the techniques and questions to be used to gain a better understanding of the three organizations' training processes.[3] Appendix C contains the suggested questions and tips from this interviewing guide that the teams used to collect data.

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[3] Tobin, Lawrence. *Team Handbook: Benchmarking Study to Identify Best Training Practices Within the Software Engineering Industry.* Simpsonville, Md.: Lawrence Tobin Associates, Inc., 1996.

4. Phase Two: General Summary of Findings

This chapter provides a general summary of the best training practices and enablers that we identified during our benchmarking study of the three industry leaders. Chapter 5 provides a more detailed description of the specific training practices and the enablers to those practices in the three organizations.

4.1 Summary of Best Practices

The three organizations that were benchmarked had certain practices in common, which we viewed as indicators of why they could be considered the best. These practices included

- a defined process for software engineering education
- a formal needs analysis activity
- availability of a wide variety of courses from different sources
- training by a local, respected organization

We will expand on each of these below.

Defined Process

The benchmarked organizations all had defined and documented processes for education.

New course development or acquisition was based on needs analysis and identification. New courses went through a quality control process to ensure that they were consistent with the stated needs. In addition, new instructors received appropriate instructor training, conducted dry runs, etc.

The organizations kept records of employee and project needs, as well as training completions. There generally was a feedback process that occurred both when a course was completed and again later to determine whether the employees thought the course had been effective. Some organizations also obtained feedback from the managers. This feedback enabled the organizations continuously to improve the quality of their training.

Needs Analysis

A formal needs analysis process was used to identify training needs. This was done by the managers, the employees, or both. In some cases a formal record of individual training needs was kept as a tracking mechanism. The most sophisticated process involved assessing gaps in skills and identifying the training needed to close the gap. Generally, needs analysis was done annually and became part of the overall training plan activity for the following year.

Course Availability

The organizations consistently had courses available from a wide variety of sources. Courses were available from in-house instructors, training vendors, and universities. Support existed for employees to take university courses for credit. In some organizations the courses had to be work related, but in other organizations any university course would be supported. Acquisition of training from vendors was generally done via a centralized process, so as to optimize use of training budgets.

Training by Local, Respected Organizations

Training was provided by local organizations that had the respect of the staff. University training was usually preferred over corporate training because it took only three to four hours a week, and the professor was local and available for help. Successful training focused on the interests and needs of the local people and was customized with examples from their environment [McCabe 96].

4.2 Summary of Enablers to Best Practices

The enablers to the best training practices included the following:

- process and quality improvement
- management involvement and support
- employee involvement
- timing of delivery compared to the identified need
- availability of training

Each of these enablers is explained in more detail below.

Process and Quality Improvement

All the organizations we benchmarked were engaged in software process improvement or quality improvement activities and were aiming for higher maturity levels and improved quality. This correlates well with the need for training, as well as the need for an established training process.

Management Involvement and Support

All the organizations reported involvement and support of all levels of management in the training process. It was felt that management support was essential to the success of the training program, particularly the support of middle management. In one organization, managers developed training plans for their areas based on the skills-gap assessments of individual employees. They then developed an action plan to close the gap.

Employee Involvement

When employees were involved in the training process and the associated needs analysis, they felt that they were getting skills improvement that would be beneficial to them in their careers. Employee involvement helped to overcome the resistance that sometimes occurred when training was viewed as a required addition to an already demanding job.

Timing of Delivery vs. Identified Need

All organizations focused on the importance of delivering the training at the right time relative to the need (i.e., not too early or too late), and they had tracking mechanisms to ensure that this took place. It is important that training be available soon before employees need to apply the skill, not soon after the need is identified.

Availability of Training

All of the benchmarked organizations reported that needed training was delivered even though budgets were flat or declining. They also reported that the availability of university courses for credit significantly helped employees to achieve their development goals.

4.3 Areas of Improvement

In the three organizations that we studied, there were a some areas that could be improved upon. These included training budget and return on investment analysis.

Training Budget

Most organizations reported flat or declining training budgets. They had learned to do more with less. As a side effect, the number of hours available to each employee on an annual basis seemed low relative to what would be needed to keep up in the field. As a result, most employees spent some of their own time obtaining training and education outside the workplace.

Return on Investment

Few organizations did return-on-investment analysis relative to training, and those that did could not readily attribute improvement to training. Usually the improvement was seen as part of a larger activity, such as software process improvement.

5. Phase Two: Specific Practices and Enablers

This chapter describes the specific practices and enablers at the three companies in our benchmarking study. We have identified the companies as A, B, and C to protect confidential information. Because the three companies were benchmarked by three different teams, the depth of the practices and enablers information within Sections 5.1-5.3 varies slightly.

Best practices are shown in italicized text. The enabler(s) to each best practice are listed directly below the practice.

5.1 Company A

5.1.1 Background

Company A is one installation of a large company operating from multiple sites. It is estimated that between 35 and 40% of the installation is directly involved in software engineering tasks. Our contact was responsible for the centralized site education department, working with vendors and management to supply the necessary training. There is also a corporate training function to which the sites can go to request training.

5.1.2 Best Practices and Enablers

We identified the following best practices and enablers during our review.

Practice: A comprehensive skills-gap assessment is completed annually for both the individual and the organization.

Enabler: A focus on skills development, not training

Enabler: Training is viewed as essential for both management and staff.

The vision of the organization is "to enhance organizational performance by accelerating development of critical skills." A major part of the job is identifying those critical skills. This is a very dynamic process. The emphasis is not strictly on training, but on skills development. A skills-gap assessment is done once a year in each area (an area consists of approximately 100 people). Questions such as, "What skills are needed?", "Is there a gap between what is needed and what is available?", "What causes the gap?", and "Is a class necessary to close the gap?", are included in the skills-gap assessment. The assessment is self-administered by managers and staff and the results are reviewed annually. The assessment forms the basis for improving individual skills and organizational capabilities.

There is a continuous effort to improve the quality of training, although not necessarily through the use of quality teams or other structured quality processes. An evaluation process is used

to continuously evaluate and verify the training. If the training manager at the centralized company site sees a need for new material to be included in training, the manager evaluates whether it is best included in an existing course or whether there is a need for a new course. The manager gives regular presentations on training to the management at Company A. The following information is included in the presentation:

- the skills-gap assessment results for that manager's area
- training that has been held
- budget requested and changes
- budget status
- student days in class (past and proposed)
- metrics
- gap analysis (yearly)
- identification of critical skills coming up that will require training (e.g., JAVA)
- books that might augment the training
- question-and-answer session

These presentations are given up the entire line of management, and information is tailored to the responsibility areas of each level of management. Part of the goal of the meeting is to get managers to confirm this information.

Although there is awareness of and interest in process improvement, the focus is not primarily on the CMM. Representatives generally have very positive feelings about the training program. They feel there has been moderate improvement in software engineering due to the training program. This improvement is measured in the decrease in the number of defects per thousand lines of code. This has been a consistent reduction, from 4 or 5 defects per KLOC (thousand lines of code) 5-10 years ago to 0.5 defect per KLOC now.

Practice: *Management is responsible for closing the skills gap.*

Enabler: Management can employ a variety of enrichment activities, including training.

Managers are very involved in planning the training for their employees. Training plans are done by managers as part of the annual review process and can be raised to the organization level. Training plans for the areas are based on the skills gap assessment, translated by the manager into an action plan to close the gap. Managers can employ a variety of training experiences, from brown bag lunch sessions all the way to formal training. These plans are working documents since needs in this area frequently change. Off-plan training can also be requested by the manager and charged against the site education budget.

Management does support training. Training is provided for all positions, including managers, although sometimes the training for managers is more of an overview. Some of the training may be designed uniquely for managers (possibly a higher level overview of some of the

more technical material). There is no predefined curriculum for the positions, but it is driven by the skills assessments done every year. Short-term curricula are developed by the areas, and the central training function tries to fill in areas where they foresee a need (e.g., object-oriented methods).

Practice: Two-tiered training planning allows for two simultaneous views of the needs of the organization: current project needs and future technology needs.

Enabler: Cross component/functional communications

Enabler: Strategic view of future technologies and needed skills

Training plans are developed by line managers and by staff within the central site training office. This complementary and supportive approach ensures the plan addresses current and future needs of employees and the organization. Training managers use the plan to promote the development of future skills. Line managers use the plan to close current skill gaps.

Employees are expected to participate actively in the planning process. The initial skills assessment is a self assessment. Much of the training that is provided will be on the employee's time, so they have to commit to that time.

5.2 Company B

5.2.1 Background

Company B has undergone a number of CMM-based appraisals. Their goal is to achieve Level 5 across the organization in the near future. Company B is a major producer of commercial and government/space technology products and services. It has a major corporate software initiative to be a premier software company. The company has made significant commitment to high quality products and mature development processes, and is leading the industry in its focus on education.

Company B's education staff is visible at the highest corporate levels and enjoys significant corporate support. Its educational resources are among the best in the industry.

5.2.2 Best Practices and Enablers

The best practices and enablers that we identified in this company are discussed below.

Practice: A quality software engineering process is incorporated into the organization's infrastructure.

Enabler: Process quality metrics are reported to higher management.

Software process improvement (SPI) is implemented throughout the corporate structure. On the commercial side of the company, there is a software engineering process group (SEPG), which acts as a steering committee; a quality assurance organization; and process action teams. The quality organization does quarterly audits of process and product quality. In addition, the software engineering teams do self assessments to assure quality.

The company uses design assurance, a software engineering resource center for tools and process support, and a chief software engineer. The chief software engineer is responsible for the quality of the software engineering effort. This individual is a key leader with process responsibilities who ensures that proper software engineering processes are assigned to appropriate staff and adhered to by the development teams.

On the government services side of the company, each new project has a process champion with responsibilities similar to those of the chief software engineer.

An award system recognizing quality performance was instituted. Quality performance had been added to position descriptions. The need for quality is communicated throughout the company.

Practice: Middle management believes in and supports efforts to improve software process quality.

Enabler: Pressure was exerted from customers, technical staff, and upper management to improve the quality of the software process.

The hardest part of implementing quality was causing the behavioral change, especially for middle management. First, people within the company had to sell quality to higher level management. A corporate quality initiative was then instituted, and the need for quality training in software engineering naturally arose from this. A quality champion was appointed to bring the message to the middle levels of the company.

Getting buy-in from top management was key to getting middle management to buy into software process quality. Pressure for quality software engineering actually arose from the technical staff. It traveled up to the executive levels, then down to the middle and lower management levels. Educating the customers about the need for software engineering quality also helped get middle management buy-in. From there, providing software engineering training was the next natural step.

Practice: Training is treated as a strategic investment.

Enabler: The organization creates an internal training capability.

Enabler: A minimum training requirement is imposed on the technical staff.

Enabler: A wide range of training opportunities is provided.

A group focused on software engineering was created within the training organization. This group might be attached to the program area and supplement the training organization. Trainers are very knowledgeable about software engineering and of immediate and specific needs. New training may be developed by internal resources, including the training organization. It may also be developed by external vendors including educational institutions. Training delivery is outsourced according to who developed it.

There are 12,000 people throughout the corporation who are engaged in software engineering-related activities. All levels of the organization support software engineering training. Employees have to take at least 40 hours of training each year, and managers are evaluated on whether their employees meet this 40-hour requirement.

Most of the software engineering courses are technical. However, courses for managers and support roles, such as configuration management and quality assurance, are being added.

Training is provided during work hours. Employees are also allowed to take college courses during working time up to 3 hours per week over and above the 40-hour minimum requirement.

Training is evaluated immediately after each class. The training organization has recently started doing follow-ups three to six months later to test for retention and use of the training. This information is used to update training content.

Practice: Training is connected with project and individual improvement needs.

Enabler: Individual and project training needs are assessed for new projects.

Enabler: Responsibility for training needs is shared between project management, training managers, and the individual.

Training is brought into every project from the beginning. Project managers determine project skill needs at the beginning of each project. Every project plan includes a training plan. Employees create their own training plans, where they prioritize their training requirements according to the needs of the project and their own strengths and weaknesses. The training organization, project management, and individuals have joint responsibility for meeting training needs.

Practice: Statistical process control is applied to software engineering processes.

Enabler: Training is provided in statistical process control tools, especially control charts.

The company applies statistical process controls, especially control charts, to track their process performance. Out-of-control situations are explored for special causes. The company might find that inexperienced and untrained employees are the cause for the out-of-control situation.

Practice: Training is continuously improved to ensure it meets customer requirements.

Enabler: Training feedback and follow-up are provided.

The training process is subject to continuous improvement based on student feedback and instructor comments. The employees provide immediate feedback and a follow-on assessment three to six months after the training. At the project level, metrics record improvement although it is not always possible to attribute improvements entirely to training. New training courses go through a rigorous evaluation process. Courses are evaluated by corporate professionals and are upgraded based on the feedback from this process.

5.3 Company C

5.3.1 Background

Company C is a large company with a substantial training staff. The company has recently undergone some cutbacks, which have affected the training staff as well as other corporate functions. The organization served by this particular training function reports to an executive vice president. About 10% of the staff are directly involved in software engineering tasks. The software engineering training group is closely connected with software process improvement. Training is obtained from a variety of sources, including in-house courses, external courses, and university courses.

5.3.2 Best Practices and Enablers

The best practices and enablers for Company C are discussed below.

Practice: There are documented practices for training.

Enabler: There is an annual planning process for identifying training needs.

Enabler: Training is a continuous improvement activity. Kirkpatrick feedback methods are used to rank student satisfaction [Kirkpatrick 94][4]. Plus/minus analysis techniques are used to determine which classes should be changed.

Enabler: Training is an integral part of the software process improvement activity.

Enabler: Course completion information is maintained in training records, which are held by human resources for all employees.

Enabler: Step-by-step procedures exist, which must be followed. If these procedures are not to be followed, a waiver must be obtained.

The organization used Levels 1 through 3 of the Kirkpatrick model to evaluate student satisfaction with the training. Level 1 of the model measures student reaction to the course, Level 2 measures whether the learning objectives were met, and Level 3 measures whether the students used the newly acquired skills and behaviors on the job.

Practice: There is good management support for training.

Enabler: Middle management provides excellent support.

Middle managers attend the executive overview course. Managers receive data on the SEPG, including training results, on an annual basis. Letters have been sent from executive management to the training department, thanking them for their participation in the achievement of a higher CMM level. Course completion certificates are given to the managers to distribute to their employees. This way the managers are in the loop and know which courses their employees have completed.

Practice: Courses are obtained from a variety of sources.

Enabler: Employees receive a tuition refund for all university courses, regardless of subject matter.

Enabler: A collaboration between industry and a university assists in obtaining outside courses.

Enabler: There is a catalog of in-house courses that are offered quarterly and on demand.

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[4] The Kirkpatrick feedback method provided the means for evaluating, and eventually improving, in-house courses. The method determines whether training was effective based on a four-level model.

The organization uses both in-house and outsourced training in its software training program. Outside vendors are usually used for classes on particular technical topics needed by specific projects. Both in-house and outsourced training, however, have the following goals:

- comply with the CMM
- provide value for the training resources spent by projects
- be provided "just-in-time"
- fit course content to the company's specific needs

The organization uses three parameters to decide whether to develop the training in house or procure the training from other sources:

- volume of training needed
- technical versus process content
- generic versus specific to the organization

In-house training is developed for all training needs that are specific to the organization and for training needs that are both high volume and process oriented. Consortium training is sought for training needs that are low volume, generic, and process oriented. The organization purchases the training from other sources (e.g., junior colleges and vendors) for generic and technically oriented training.

The organization's goal is to provide 40 hours of training each year for each staff member. This training is to be provided on company time and must be directly relevant to the employee's job and position.

Practice: Training is delivered "just-in-time."

Enabler: The training organization is nimble enough to be able to adjust schedules so that courses can be offered "just in time." This applies to in-house courses as well as external courses.

Practice: The training process is continuously improved.

Enabler: Kirkpatrick Level 2 or Level 3 feedback is used.

Enabler: Measurements are used to determine whether training is effective. There are standard evaluation forms for all classes. These are summarized in a monthly report for managers.

Enabler: Human Resources staff are involved in training, provide some instructor training, and observe classes.

Enabler: Training is an integral part of SPI and is included in the plan to reach the next CMM level.

Training in software engineering process is done by a separate group, whose members are knowledgeable in software engineering.

The software process training evolved over a number of years to accommodate the following tradeoffs:

- training on company time versus employee time
- training in basic software courses versus the full component of software process courses
- use of in-class training versus self-paced tutorials
- use of courses that are developed fully in house vs. a combination of both in-house and outsourced courses

In 1992, the basic set of training materials included a software project management course, an initial software engineering process course, a class on how to train review leaders, and an executive overview for all upper management. Since then, the organization has made changes to these basic courses based on the following factors:

- need for off-site training
- feedback from attendees (Kirkpatrick method)
- the need to limit in-class time
- availability of the CMM Version 1.1
- the requirement to cover different and additional training material

Management has required that the organization have a corporate roadmap to reach CMM Level 4.

Practice: Classes are effective.

Enabler: Classes are practical and hands on. For example, real student problems are used in teaching software project management. The students do cost estimating for their own projects.

Enabler: A variety of delivery mechanisms are used, such as video and other multimedia.

Enabler: Students are excited about the value of the classes.

Students completed a survey after each class to address Level 1 of the Kirkpatrick model. The survey presented a number of statements, to which students indicated their agreement or disagreement, in varying degrees. Examples of survey statements include

- The course materials were useful.
- The instructor's presentation was effective.
- The instructor maintained my interest in the course.

- I can apply these ideas/techniques to my (or my team's) work.
- The ideas/techniques presented will help me (or my team) better achieve my (our) goals.

The survey also provided space for students to comment on other topics such as what they liked best or least about the course and how the material presented in the course would apply to their jobs.

Appendix A: Initial Survey

Benchmarking Study to Identify Best Training Practices Within the Software Engineering Industry

Questionnaire

Please complete all applicable sections of the questionnaire. Please mail or fax the completed questionnaire to Larry Tobin at the above address. **All data is confidential.**

Name of person completing this questionnaire: _____

Position title: _____

Room number/mail stop: _____

Office telephone number: _____

Company name:

_____

Company address: _____

_____

Does your organization provide or make available training to any members of its work force?

yes ___, no, organization-sponsored training is not available to employees ___,

(If you answer "No" to this question, do not complete the remaining questions. Please return the questionnaire.)

A. Introduction

1. Has a software capability assessment (SCE) been conducted in your organization?

   yes ____, no ____, don't know ____

2. If yes, are you engaged in a Software Process Improvement Program? ____

3. In your opinion, has training affected software engineering within your organization?

   significant improvement: ___
   moderate improvement: ___
   some improvement: ___
   no improvement: ___

B. Staff Development Questions:

1. How many people in your organization are in software related fields?

   ____ employees, don't know ____

2. Is software engineering and related training available?

   yes ____, no ____, don't know ____

3. Do you feel that management supports software engineering training?

   executive management: yes ___, no ___, no opinion ___
   middle management: yes ___, no ___, no opinion ___
   supervisory (project) management yes ___, no ___, no opinion ___

4. Is training provided for all software engineering-related job classification levels, including managers and support staff?

   yes ____, no ____, don't know ____

5. Are employees encouraged by management to attend training classes?

   yes ____, no ____, don't know ____

6. Is time allowed during work hours for training?

   yes ____, no ____, don't know ____

7. Are people within the organization generally satisfied with the training they receive?

   yes ____, no ____, don't know ____

8. In general, is the training budget:

   increasing ___, decreasing ___, same as last year ___, no separate budget ___

9. For software engineering and related disciplines, is the training budget:

   increasing ___, decreasing ___, same as last year ___, no separate budget ___

C. Training Process

1. Is there a separate group responsible for providing software engineering and related training?

   yes ____, no ____, don't know ____

2. Is this group knowledgeable of software engineering and related functions?

very knowledgeable ___
knowledgeable ___
not knowledgeable ___
don't know ___

3. Are new training programs developed: (check all that apply)

internally ___, by vendors/consultants ____, by university partners ___

4. Is training delivery out-sourced (vendors, consultants, university partners, etc.)

training delivery is totally out-sourced____
training delivery is partially out-sourced ____, approximate percentage ___
training delivery is not out-sourced ____

5. Are training procedures documented?

creating training plans: yes ___, no ___, don't know ___
performing training needs analyses: yes ___, no ___, don't know ___
requesting training: yes ___, no ___, don't know ___
training development: yes ___, no ___, don't know ___
training procurement: yes ___, no ___, don't know ___
registering for training: yes ___, no ___, don't know ___
training delivery: yes ___, no ___, don't know ___
training evaluation: yes ___, no ___, don't know ___

6. Is the training process subject to continuous improvement?

   yes ____, no ____, don't know ____

7. Is training: (check all that apply)

   instructor led ___, computer-based ___

8. How effective is your training process?

   very effective: ___
   effective: ___
   not effective: ___

D. Measurement

1. Does the organization measure the value of training provided?

   yes ____, no ____, don't know ____

2. If yes, to what level?
   ___ learning has occurred
   ___ application on the job
   ___ return on investment
   ___ customer satisfaction indicators

3. Are metrics collected such as student days, enrollment vs. attendance, training planned vs. training provided?

   yes ____, no ____, don't know ____

4. Are employee training records kept?

   yes ____, no ____, don't know ____

5. Is training's contribution to productivity improvement advertised throughout the software engineering organization?

   yes ____, no ____, don't know ____

6. Is training independently evaluated by a qualified group outside the training organization?

   yes ____, no ____, don't know ____

7. Are training activities regularly reported to senior management using a documented procedure?

   yes ____, no ____, don't know ____

8. How effective is your measurement process?

   very effective: ___

   effective: ___

   not effective: ___

E. Planning & Requirements

1. Is there a vision/mission statement for training?

   yes ____, no ____, don't know ____

2. Does the training group interact with operations managers to discuss training needs?

   yes ____, no ____, don't know ____

3. Are training needs assessments conducted?

   always ___, sometimes ___, never ___, don't know ____

4. Are training plans produced?

   for individuals: yes ____, no ____, don't know ____

   for organizational units: yes ____, no ____, don't know ____

5. If yes, can "off-the-plan" training be requested: (check all that apply)

   by operating managers ___
   by training managers ___

   directly by employees ___

   not at all ___

6. Are training plans maintained?

   maintained ___, ignored ___

7. Are training needs:

   always met___, sometimes met___, never met___, don't know___

8. On average, how much time elapses between the identification of a training need and the delivery of training?

when training is purchased	___ days	don't know ___
when training exists in house	___ days	don't know ___
when training must be developed	___ days	don't know ___

9. How effective is your planning and requirements process?

very effective: ___

effective: ___

not effective: ___

Appendix B: Initial Survey Results

Summary Data of Benchmark Study to Identify Best Training Practices Within the Software Engineering Industry ***10/27/96***

Total Number of People completing the Questionnaire: 24

Does your organization provide or make available training to any members of its work force?

# of YES responses	24	YES as a % of responses	100%
# of NO responses	0	NO as a % of responses	0%
# of responses to question	24	Responses as a % of total questionnaires	100%

A. Introduction

1. Has a CMM Based Appraisal (CBA) been conducted in your organization?

# of YES responses	17	YES as a % of responses	71%
# of NO responses	4	NO as a % of responses	17%
# of DON'T KNOW responses	3	DON'T KNOW as a % of responses	13%
Total # responding	24	Responses as a % of total questionnaires	100%

2. If yes, are you engaged in a Software Process Improvement Program?

# of YES responses	17	YES as a % of responses	100%
# of NO responses	0	NO as a % of responses	0%
# of DON'T KNOW responses	0	DON'T KNOW as a % of responses	0%
Total # responding	17	Responses as a % of total questionnaires	71%

3. In your opinion, has training affected software engineering within your organization?

# of SIGNIFICANT responses	4	SIGNIFICANT as a % of responses	18%
# of MODERATE responses	13	MODERATE as a % of responses	59%
# of SOME responses	5	SOME as a % of responses	23%
# of NO responses	0	NO as a % of total questionnaire	0%
Total # responding	22	Responses as a % of total questionnaires	92%

B. Staff Development Questions

1. How many people in your organization are in software related fields?

# of employee responses	21	Average of average employees given	1805.90476190476
# of DON'T KNOW responses	3		
Total # responding	24	Responses as a % of total questionnaires	100%

2. Is software engineering and related training available?

# of YES responses	24	YES as a % of responses	100%
# of NO responses	0	NO as a % of responses	0%
# of DON'T KNOW responses	0	DON'T KNOW as a % of responses	0%
Total # responding	24	Responses as a % of total questionnaires	100%

3. Do you feel that management supports software engineering training?

Executive Management:

# of YES responses	19	YES as a % of responses	79%
# of NO responses	3	NO as a % of responses	13%
# of NO OPINION responses	2	NO OPINION as a % of responses	8%
Total # responding	24	Responses as a % of total questionnaires	100%

Middle Management:

# of YES responses	22	YES as a % of responses	92%
# of NO responses	1	NO as a % of responses	4%
# of NO OPINION responses	1	NO OPINION as a % of responses	4%

Supervisory (project) Management:

# of YES responses	21	YES as a % of responses	88%
# of NO responses	3	NO as a % of responses	13%
# of NO OPINION responses	0	NO OPINION as a % of responses	0%
Total # responding	24	Responses as a % of total questionnaires	100%

4. Is training provided for all software engineering-related job classification levels, including managers and support staff?

# of YES responses	19	YES as a % of responses	79%
# of NO responses	3	NO as a % of responses	13%
# of DON'T KNOW responses	2	DON'T KNOW as a % of responses	8%
Total # responding	24	Responses as a % of total questionnaires	100%

5. Are employees encouraged by management to attend training classes?

# of YES responses	21	YES as a % of responses	88%
# of NO responses	2	NO as a % of responses	8%
# of DON'T KNOW responses	1	DON'T KNOW as a % of responses	4%
Total # responding	24	Responses as a % of total questionnaires	100%

6. Is time allowed during work hours for training?

# of YES responses	24	YES as a % of responses	100%
# of NO responses	0	NO as a % of responses	0%
# of DON'T KNOW responses	0	DON'T KNOW as a % of responses	0%
Total # responding	24	Responses as a % of total questionnaires	100%

7. Are people within the organization generally satisfied with the training they receive?

# of YES responses	17	YES as a % of responses	71%
# of NO responses	3	NO as a % of responses	13%
# of DON'T KNOW responses	4	DON'T KNOW as a % of responses	17%
Total # responding	24	Responses as a % of total questionnaires	100%

8. In general, is the training budget:

# of INCREASING responses	3	INCREASING as a % of responses	14%
# of DECREASING responses	10	DECREASING as a % of responses	45%
# of SAME responses	5	SAME as a % of responses	23%
# of NO SEPARATE responses	4	NO SEPARATE as a % of total questionnaire	18%
Total # responding	22	Responses as a % of total questionnaire	92%

9. For software engineering and related disciplines, is the training budget:

# of INCREASING responses	7	INCREASING as a % of responses	30%
# of DECREASING responses	6	DECREASING as a % of responses	26%
# of SAME responses	4	SAME as a % of responses	17%
# of NO SEPARATE responses	6	NO SEPARATE as a % of total questionnaire	26%
Total # responding	23	Responses as a % of total questionnaire	96%

C. Training Process

1. Is there a separate group responsible for providing software engineering and related

# of YES responses	19	YES as a % of responses	79%
# of NO responses	5	NO as a % of responses	21%
# of DON'T KNOW responses	0	DON'T KNOW as a % of responses	0%
Total # responding	24	Responses as a % of total questionnaires	100%

2. Is this group knowledgeable of software engineering and related functions?

# of VERY responses	12	VERY as a % of responses	57%
# of KNOWLEDGEABLE responses	7	KNOWLEDGEABLE as a % of responses	33%
# of NOT responses	2	NOT as a % of responses	10%
# of DON'T KNOW responses	0	DON'T KNOW as a % of total questionnaire	0%
Total # responding	21	Responses as a % of total questionnaire	88%

3. Are new training programs developed:

# of INTERNALLY responses	22	INTERNALLY as a % of responses	92%
# of VENDORS/CONS responses	20	VENDORS as a % of responses	83%
# of UNIVERSITY responses	12	UNIVERSITY as a % of responses	50%
Total # responding	24	Responses as a % of total questionnaires	100%

4. Is training delivery out-sourced (vendors, consultants, university partners, etc.)?

# of TOTALLY responses	1	TOTALLY as a % of responses	4%
# of PARTIALLY responses	19	PARTIALLY as a % of responses	83%
# of NOT responses	3	NOT as a % of responses	13%
Total # responding	23	Responses as a % of total questionnaires	96%
Average of % PARTIALLY out-sourced	40%		

5. Are training procedures documented?

Creating Training Plans:

# of YES responses	14	YES as a % of responses	58%
# of NO responses	7	NO as a % of responses	29%
# of DON'T KNOW responses	3	DON'T KNOW as a % of responses	13%
Total # responding	24	Responses as a % of total questionnaires	100%

Performing training needs analyses:

# of YES responses	16	YES as a % of responses	67%
# of NO responses	5	NO as a % of responses	21%
# of DON'T KNOW responses	3	DON'T KNOW as a % of responses	13%
Total # responding	24	Responses as a % of total questionnaires	100%

Requesting training:

# of YES responses	18	YES as a % of responses	75%
# of NO responses	4	NO as a % of responses	17%
# of DON'T KNOW responses	2	DON'T KNOW as a % of responses	8%
Total # responding	24	Responses as a % of total questionnaires	100%

Training development:

# of YES responses	18	YES as a % of responses	75%
# of NO responses	5	NO as a % of responses	21%
# of DON'T KNOW responses	1	DON'T KNOW as a % of responses	4%
Total # responding	24	Responses as a % of total questionnaires	100%

Training Procurement:

# of YES responses	16	YES as a % of responses	67%
# of NO responses	6	NO as a % of responses	25%
# of DON'T KNOW responses	2	DON'T KNOW as a % of responses	8%
Total # responding	24	Responses as a % of total questionnaires	100%
Total # responding	24	Responses as a % of total questionnaires	100%

Registering for training:

# of YES responses	21	YES as a % of responses	88%
# of NO responses	2	NO as a % of responses	8%
# of DON'T KNOW responses	1	DON'T KNOW as a % of responses	4%
Total # responding	24	Responses as a % of total questionnaires	100%

Training delivery:

# of YES responses	19	YES as a % of responses	79%
# of NO responses	2	NO as a % of responses	8%
# of DON'T KNOW responses	3	DON'T KNOW as a % of responses	13%
Total # responding	24	Responses as a % of total questionnaires	100%

Training evaluation:

# of YES responses	20	YES as a % of responses	83%
# of NO responses	2	NO as a % of responses	8%
# of DON'T KNOW responses	2	DON'T KNOW as a % of responses	8%
Total # responding	24	Responses as a % of total questionnaires	100%

6. Is the training process subject to continuous improvement?

# of YES responses	21	YES as a % of responses	88%
# of NO responses	1	NO as a % of responses	4%
# of DON'T KNOW responses	2	DON'T KNOW as a % of responses	8%
Total # responding	24	Responses as a % of total questionnaires	100%

7. Is training:

# of INSTRUCTOR LED responses	24	INSTRUCTOR LED as a % of responses	100%
# of COMPUTER-BASED responses	12	COMPUTER-BASED as a % of responses	50%
Total # responding	24	Responses as a % of total questionnaires	100%

8. How effective is your training process?

# of VERY responses	4	VERY EFFECTIVE as a % of responses	17%
# of EFFECTIVE responses	17	EFFECTIVE as a % of	71%
# of NOT responses	3	NOT EFFECTIVE as a % of responses	13%
Total # responding	24	Responses as a % of total questionnaires	100%

D. Measurement

1. Does the organization measure the value of training provided?

# of YES responses	17	YES as a % of responses	71%
# of NO responses	7	NO as a % of responses	29%
# of DON'T KNOW responses	0	DON'T KNOW as a % of responses	0%
Total # responding	24	Responses as a % of total questionnaires	100%

2. If yes, to what level?

# of LEARNING HAS OCCURRED responses	8	LEARNING as a % of responses	50%
# of APPLICATION ON THE JOB responses	8	APPLICATION as a % of responses	50%
# of RETURN ON INVESTMENT responses	1	ROI as a % of responses	6%
# of CUSTOMER SATISFACTION responses	8	CUSTOMER as a % of responses	50%
Total # responding	16	Responses as a % of total questionnaires	67%

3. Are metrics collected such as student days, enrollment vs. attendance, training planned vs. training provided?

# of YES responses	24	YES as a % of responses	100%
# of NO responses	0	NO as a % of responses	0%
# of DON'T KNOW responses	0	DON'T KNOW as a % of responses	0%
Total # responding	24	Responses as a % of total questionnaires	100%

4. Are employee training records kept?

# of YES responses	21	YES as a % of responses	88%
# of NO responses	2	NO as a % of responses	8%
# of DON'T KNOW responses	1	DON'T KNOW as a % of responses	4%
Total # responding	24	Responses as a % of total questionnaires	100%

5. Is training's contribution to productivity improvement advertised throughout the software engineering organization?

# of YES responses	6	YES as a % of responses	25%
# of NO responses	15	NO as a % of responses	63%
# of DON'T KNOW responses	3	DON'T KNOW as a % of responses	13%
Total # responding	24	Responses as a % of total questionnaires	100%

6. Is training independently evaluated by a qualified group outside the training organization?

# of YES responses	11	YES as a % of responses	46%
# of NO responses	12	NO as a % of responses	50%
# of DON'T KNOW responses	1	DON'T KNOW as a % of responses	4%
Total # responding	24	Responses as a % of total questionnaires	100%

7. Are training activities regularly reported to senior management using a documented procedure?

# of YES responses	16	YES as a % of responses	67%
# of NO responses	6	NO as a % of responses	25%
# of DON'T KNOW responses	2	DON'T KNOW as a % of responses	8%
Total # responding	24	Responses as a % of total questionnaires	100%

8. How effective is your measurement process?

# of VERY responses	2	VERY EFFECTIVE as a % of responses	9%
# of EFFECTIVE responses	14	EFFECTIVE as a % of responses	61%
# of NOT responses	7	NOT EFFECTIVE as a % of responses	30%
Total # responding	23	Responses as a % of total questionnaires	96%

E. Planning and Requirements

1. Is there a vision/mission statement for training?

# of YES responses	14	YES as a % of responses	58%
# of NO responses	5	NO as a % of responses	21%
# of DON'T KNOW responses	5	DON'T KNOW as a % of responses	21%
Total # responding	24	Responses as a % of total questionnaires	100%

2. Does the training group interact with operations managers to discuss training needs?

# of YES responses	18	YES as a % of responses	78%
# of NO responses	1	NO as a % of responses	4%
# of DON'T KNOW responses	4	DON'T KNOW as a % of responses	17%
Total # responding	23	Responses as a % of total questionnaires	96%

3. Are training needs assessments conducted?

# of ALWAYS responses	5	ALWAYS as a % of responses	21%
# of SOMETIMES responses	13	SOMETIMES as a % of responses	54%
# of NEVER responses	2	NEVER as a % of responses	8%
# of DON'T KNOW responses	4	DON'T KNOW as a % of total questionnaire	17%
Total # responding	24	Responses as a % of total questionnaire	100%

4. Are training plans produced?

For individuals:

# of YES responses	13	YES as a % of responses	54%
# of NO responses	6	NO as a % of responses	25%
# of DON'T KNOW responses	5	DON'T KNOW as a % of responses	21%
Total # responding	24	Responses as a % of total questionnaires	100%

For organizational units:

# of YES responses	17	YES as a % of responses	71%
# of NO responses	4	NO as a % of responses	17%
# of DON'T KNOW responses	3	DON'T KNOW as a % of responses	13%
Total # responding	24	Responses as a % of total questionnaires	100%

5. If yes, can "off-the-plan" training be requested:

# of OPS MGR responses	18	OPS MGR as a % of responses	95%
# of TRAINING MGR responses	15	TRAINING MGR as a % of responses	79%
# of DIRECT responses	16	DIRECT as a % of responses	84%
# of NOT AT ALL responses	0	NOT AT ALL as a % of responses	0%
Total # responding	19	Responses as a % of total questionnaires	79%

6. Are training plans maintained?

# of MAINTAINED responses	14	MAINTAINED as a % of responses	88%
# of IGNORED responses	2	IGNORED as a % of responses	13%
Total # responding	16	Responses as a % of total questionnaires	67%

7. Are training needs:

# of ALWAYS MET responses	0	ALWAYS as a % of responses	0%
# of SOMETIMES MET responses	20	SOMETIMES as a % of responses	87%
# of NEVER MET responses	0	NEVER as a % of responses	0%
# of DON'T KNOW responses	3	DON'T KNOW as % of total questionnaire	13%
Total # responding	23	Responses as a % of total questionnaire	96%

8. On average, how much time elapses between the identification of a training need and the delivery of training?

When training is purchased:

# of PURCHASED responses	15	Average of average days given	47.4666666666667
# of DON'T KNOW responses	6		
Total # responding	21	Responses as a % of total questionnaires	88%

When training exists in house:

# of EXISTS responses	15	Average of average days given	39
# of DON'T KNOW responses	5		
Total # responding	20	Responses as a % of total questionnaires	83%

When training must be developed:

# of DEVELOP responses	12	Average of average days given	120
# of DON'T KNOW responses	6		
Total # responding	18	Responses as a % of total questionnaires	75%

9. How effective is your planning and requirements process?

# of VERY responses	0	VERY EFFECTIVE as a % of responses	0%
# of EFFECTIVE responses	17	EFFECTIVE as a % of responses	77%
# of NOT responses	5	NOT EFFECTIVE as a % of responses	23%
Total # responding	22	Responses as a % of total questionnaires	92%

Appendix C: Interview Questions

Section A. Introduction

Question A-1: If a CMM-Based Appraisal (CBA) has been conducted, inquire into the findings.

Question A-2: If the phase one answer to this question is "yes," ask how the software process improvement (SPI) has been implemented in the organization. Ask whether it is based on the CMM, or another model. Try to understand how the organization has changed to implement SPI, the tactical strategies employed to facilitate behavioral change, and how changes are controlled from the management perspective. Although more detailed questions follow, determine whether training is considered to be a formal part of the SPI program. Develop a complete picture of the implementation approach. Consider developing a flow chart as a means for displaying the implementation process. This question has the potential for gathering a large amount of data.

If the phase one answer to this question is "no," ask why not? Explore reasons against SPI especially in terms of cost, perceived need, organizational size and structure, and culture.

Question A-3: Ask the basis for the answer given for this question. The answer should clearly indicate objective versus subjective bases. If the answer was based on subjective factors, inquire what those factors are.

Section B. Staff Development Questions

Question B-1: Attempt to determine the percentage of personnel directly involved in software engineering tasks. Include managers, developers and other professional staff in the count.

Question B-2: Obtain a list of available software engineering-related training classes.

Question B-3: Determine the bases for these answers. How is this support expressed?

Question B-4: If not revealed in Question B-2, determine whether curricula exist for software engineering-related positions. Determine the basis for the curricula; e.g. CMM-based, University developed, etc.

Question B-5: If the answer is "yes," determine how this encouragement is expressed. If the answer is "no" or "don't know," determine why not.

Question B-6: If the answer is "yes," determine whether this policy causes hardship to the organization. If yes, identify the strategies employed to overcome these negative impacts. If the answer is "no" or "don't know," ask when training is provided, and whether employee reactions to this scheduling have been tracked. Determine the nature of these reactions, and the degree to which employees support the training program.

Question B-7: If the answer is "yes," determine how the benchmarking partner knows that people are satisfied with the training. Also, determine why they are satisfied. If the answer is "no", determine how the benchmarking partner knows this, and why students are not satisfied.

Question B-8: Actual dollars spent on training is not important. Determine the percentage change in the training budget since the last budget year. Determine why there has been a change, and the impacts of the change on training.

Question B-9: Actual dollars spent on training is not important. Determine the percentage change in the software engineering training budget since the last budget year. Determine why there has been a change, and the impacts of the change on software engineering training.

Section C. Training Process

Question C-1: If the answer is "yes," ask for the name of the group, and the number of staff assigned. If the answer is "no" or "don't know," ask how software engineering training is handled organizationally. Skip to question C-3.

Question C-2: If the answer is "knowledgeable or very knowledgeable," ask how staff are selected and trained. Are there technical requirements for training positions? Also, ask how the knowledge of the software engineering training staff is assessed, and whether there is a mechanism for continually upgrading the knowledge base of the software engineering training group. In addition, determine whether the software engineering training group receives instruction on developing and/or delivering training materials.

If the answer is "not knowledgeable," determine how the benchmarking partner makes up for this lack of knowledge, if at all. In addition, determine the impact on software engineering training overall by the lack of a knowledgeable training group.

Question C-3: If multiple sources are used, determine the basis for dividing the development work.

Question C-4: If multiple sources are used, determine the basis for dividing the delivery work.

Question C-5: For "yes" answers in the categories listed under this question, determine whether the procedures are available. If available, request copies. Otherwise, determine the content of the procedures. For "no" answers in the categories listed under this question, determine what, if anything, is done in these areas.

Question C-6: If the answer is "yes," determine how continuous improvement is applied to training. Are quality improvement teams employed? Are decisions which change the training process based on data? If appropriate, prepare a flow chart or diagram of the continuous improvement process. If the answer is "no" or "don't know," ask if there is a process for insuring that customer training requirements are met. If so, identify the process.

Question C-7: If multiple answers are indicated, determine how the decision is made whether to use an instructor and/or computer-based training.

Question C-8: Determine why the training process is either very effective, effective, or not effective. Determine if there are critical success factors for software engineering training (or training in general), and what they are. If you don't understand the training process, ask for clarification and create a new flowchart or correct a flowchart already prepared. Finally, understand whether the answer is based on empirical or subjective data.

Section D. Measurement

Question D-1: If the answer is "yes," determine how training value is defined. If reports are prepared, request copies. If the answer is "no" or "don't know," skip to question D-3.

Question D-2: Identify the procedures used to evaluate training. Obtain copies of any forms, questionnaires, and reports related to measuring the value of training. Understand the entire measurement and evaluation process. If appropriate, prepare a flowchart or other diagram to illustrate the process.

Question D-3: If the answer is "yes," identify all the metrics used to analyze and evaluate training data. Also, determine how and when these metrics are used, and the significance of each metric. If the answer is "no" or "don't know," ask whether reports are produced that provide measures that can be related to the value of training. Obtain examples of any such measures.

Question D-4: If the answer is "yes," identify the data elements stored in these training records. If the answer is "no" or "don't know," ask if it is important to the organization what training courses an employee has completed. Determine if promotions or work awards take training into account. If training is taken into account, determine how the organization knows what training was taken by the employee.

Question D-5: If the answer is "yes," determine the communication methods and strategies used. If the answer is "no" or "don't know," determine if information on contract awards, software engineering project successes, or related information is distributed, and how it is disseminated.

Question D-6: If the answer is "yes," determine if this is done periodically. Also, identify the information gathered, and the results of the latest survey. If the answer is "no" or "don't know," determine if any audits of the training department are conducted; by whom, what data are collected, and how often.

Question D-7: If the answer is "yes," obtain a copy of the procedure. Determine how often the reports are made, and the information typically provided. If the answer is "no" or "don't know," determine if management has any concerns about training, and what they are.

Question D-8: Determine why the measurement process is either very effective, effective, or not effective. If you don't understand the measurement process, ask for clarification and create a new flowchart or correct a flowchart already prepared. Finally, understand whether the answer is based on empirical or subjective data.

Section E. Planning and Requirements

Question E-1: If the answer is "yes," obtain a copy of the vision and/or mission statement. Determine how the vision/mission is communicated to the training units. Identify the training objectives and goals that are associated with the vision/mission, and how the organization knows these objectives and goals are accomplished. If appropriate, illustrate the vision and/mission deployment strategy in chart or flow diagram form. Conclude by determining how aware the training staff is of the vision/mission and their role in its implementation. If the answer is "no" or "don't know," determine if training objectives and goals exist, and if they do, what they are and how they are formulated.

Question E-2: If the answer is "yes," describe the process. If the answer is "no" or "don't know," determine how or if manager input is factored into training decisions.

Question E-3: If the answer is "always" or "sometimes" determine if there is a standard format for needs assessments, and obtain a copy of that format. If the answer is "sometimes," "never," or "don't know," determine how decisions on course requirements are made, who makes them, and their accuracy in selecting course content.

Question E-4: If the answer is "yes," obtain an example of a sample plan. If the answer is "no" or "don't know," ask how training courses are selected, and what factors influence scheduling.

Question E-5: If blocks are checked, determine if special procedures are required to select off-the-plan courses. Obtain a copy of these procedures.

Question E-6: If the answer is "maintained," determine who maintains the records. What data are updated to the records. If the answer is "ignored," determine why this happens.

Question E-7: Determine how the benchmarking partner knows for sure that the response to this question is accurate.

Question E-8: If days-data are shown, determine whether these values are acceptable to the organization. Is anything being done to shorten cycle times? If so, what?

Question E-9: Determine why the planning and requirements process is either very effective, effective, or not effective. If you don't understand the planning and requirements process, ask for clarification. Create a new flowchart or correct a flowchart already prepared. Finally, understand whether the answer is based on empirical data or subjective data.

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[APQC 96] American Productivity and Quality Centre, International Benchmarking Clearinghouse, can be found at http://www.apqc.org/

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THIS REPORT PROVIDES THE RESULTS OF A BENCHMARKING STUDY TO IDENTIFY THE BEST TRAINING PRACTICES WITHIN THE SOFTWARE ENGINNEERING COMMUNITY. WE SURVEYED 24 ORGANIZATIONS TO CREATE A BROAD PICTURE OF TRAINING AS IT CURRENTLY EXISTS IN INDUSTRY. WE THEN CHOSE THREE OF THESE ORGANIZATIONS FOR AN IN-DEPTH STUDY TO IDENTIFY THE BEST TRAINING PRACTICES AND ENABLERS TO THOSE PRACTICES. THIS REPORT SUMMARIZES THE RESULTS OF THE SURVEY AND THE IN-DEPTH STUDY, AND DISCUSSES THE BEST PRACTICES AND ENABLERS THAT WERE IDENTIFIED.

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